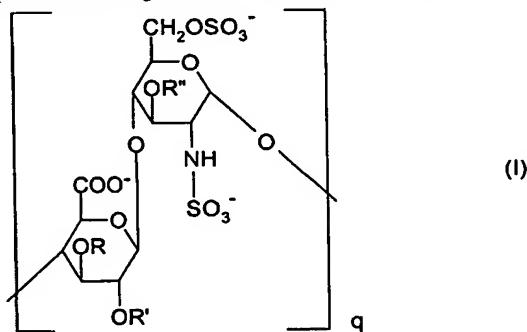


CLAIMS

1. A LMW-K5-N,O-oversulfate having a mean molecular weight of from about 3,000 to about 6,000 and a degree of sulfation of from 3.2 to 4.

5 2. The LMW-K5-N,O-oversulfate of claim 1 consisting of a mixture of chains in which the preponderant species has the formula I



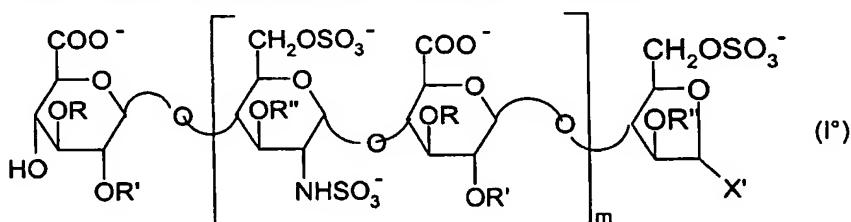
10 wherein q is 4, 5, 6, 7, or 8, R, R' and R" represent hydrogen or a SO₃⁻ group, for a degree of sulfation of from 3.2 to 4, and the corresponding cation is a chemically or pharmaceutically acceptable one.

15 3. The LMW-K5-N,O-oversulfate of claim 1 or 2 having a mean molecular weight of 3,750-4,250

4. The LMW-K5-N,O-oversulfate of claim 1 or 2 having a mean molecular weight of 4,750-5,250.

5. The LMW-K5-N,O-oversulfate of claim 1 or 2 having a mean molecular weight of 5,750-6,250.

6. The LMW-K5-N,O-oversulfate of claim 1 or 2 consisting of a mixture of chains in which the preponderant species is a compound of formula I'

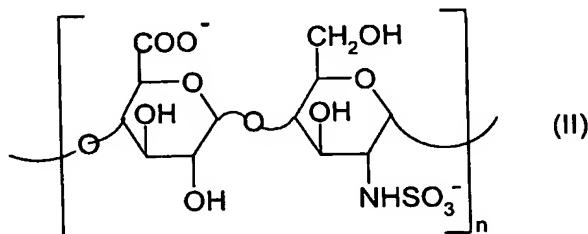


20 in which R, R' and R" represent hydrogen or SO₃⁻, X' represents a formyl or hydroxymethyl group, for a degree of sulfation of from 3.2 to 4, m represents 4, 5 or 6 and the corresponding cation is a chemically or pharmaceutically acceptable one.

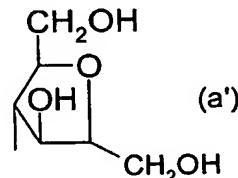
7. The LMW-K5-N,O-versulfate according to claim 6, having a mean molecular weight of 3,750-4,250.
8. The LMW-K5-N,O-versulfate according to claim 6, having a mean molecular weight of 4,750-5,250.
- 5 9. The LMW-K5-N,O-versulfate according to claim 6, having a mean molecular weight of 5,750-6,250
- 10 10. A LMW-K5-N,O-versulfate according to one of claims from 1 to 9, having a degree of sulfation of from 3.5 to 4.
11. A LMW-K5-N,O-versulfate according to one of claims from 1 to 9, having a degree of sulfation of from 3.5 to 3.9.
12. A process for the preparation of a LMW-K5-N,O-versulfate having a degree of sulfation of from 3.2 to 4, which comprises
 - (a) treating a LMW-K5-N-sulfate obtained by nitrous depolymerization of a K5-N-sulfate and subsequent reduction, in its acidic form, with a tertiary amine or quaternary ammonium hydroxide, letting the reaction mixture to stand for a period of time of 30-60 minutes by maintaining the pH of the solution at 7 and isolating its salt with said organic base;
 - (b) treating said tertiary amine or quaternary ammonium salt of said polysaccharide with an O-sulfating agent under O-versulfation conditions;
 - 20 (c) treating the product thus obtained with a N-sulfating agent and isolating the LMW-K5-N,O-versulfate thus obtained.
13. A process according to claim 12, which comprises
 - (i) submitting a K5-N-sulfate to a nitrous depolymerisation followed by a reduction, for example by sodium borohydride;
 - (ii) treating a LMW-K5-N-sulfate, in its acidic form, with a tertiary amine or quaternary ammonium hydroxide, letting the reaction mixture to stand for a period of time of 30-60 minutes, whereby the pH of the solution is maintained at 7, and isolating the corresponding tertiary amine or quaternary ammonium salt;
 - 25 (iii) treating said tertiary amine or quaternary ammonium salt of said LMW-K5-N-sulfate with an O-sulfation reactant under O-versulfation conditions;
 - (iv) treating the product thus obtained with a N-sulfating agent and isolating the obtained LMW-K5-N,O-versulfate.

14. A process according to claim 12, wherein said reduction is carried out with sodium borohydride.

15. A process according to claim 12, wherein a LMW-K5-N-sulfate consisting of a mixture of chains in which at least 90% of said chains has the formula II



wherein n is an integer from 2 to 20, containing a 2,5 anhydromannitol unit of structure (a')

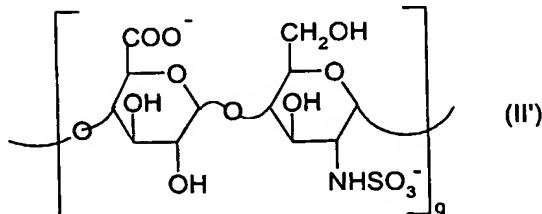


10 at the reducing end of the majority of chains in said mixture of chains, and the corresponding cation is a chemically and pharmaceutically acceptable one, is used as starting material.

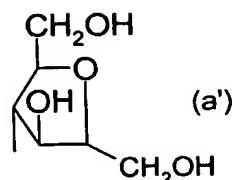
16. A process according to one of claims 12 to 14, wherein said K5-N-sulfate starting material is free of lipophilic substances.

15 17. A process according to one of claims from 12 and 14 to 16, wherein the LMW-K5-N-sulfate starting material is used in the form of its sodium salt.

18. A process according to one of claims 12 and 14 to 16, wherein said K5-N-sulfate starting material consists of a mixture of chains in which the preponderant species is a compound of formula II'

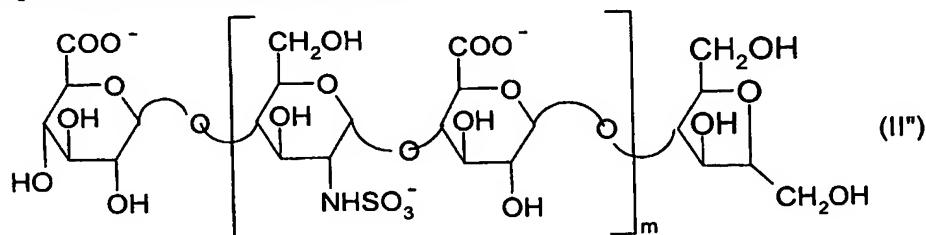


in which q is 4, 5, 6, 7, or 8, containing a 2,5 anhydromannitol unit of structure (a')



at the reducing end of the majority of the chains in said mixture of chains, and the corresponding cation is a chemically or pharmaceutically acceptable one.

5 19. A process according to one of the claims 12 and 14 to 18, wherein said K5-N-sulfate starting material consists of a mixture of chains in which the preponderant species is a compound of formula II'



10 in which m represents 4, 5 or 6 and the corresponding cation is a chemically or pharmaceutically acceptable one.

20 20. A process according to one of the claims 12 to 19, wherein the LMW-K5-N,O-oversulfate is obtained in its sodium salt form and optionally transformed into another chemically or pharmaceutically acceptable salt.

21. A LMW-K5-amine-O-oversulfate obtainable by the steps (a) and (b) of the process according one of claims from 12 to 20, or a chemically or pharmaceutically acceptable salt thereof.

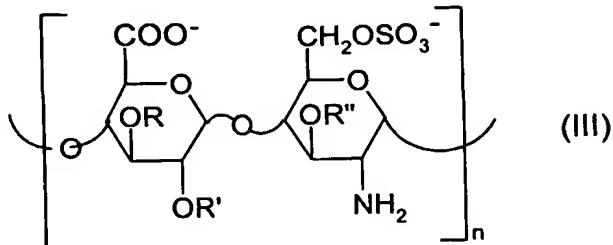
22. A LMW-K5-amine-O-oversulfate having a degree of sulfation of from 2.2 to 3 or one of its chemically or pharmaceutically acceptable salts.

23. A LMW-K5-amine-O-oversulfate according to one of claims 21 and 22, having a mean molecular weight of from about 3,500 to about 11,000 or a chemically or pharmaceutically acceptable salt thereof.

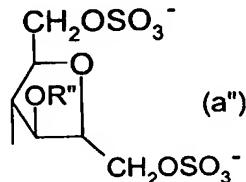
24. A LMW-K5-amine-O-oversulfate according to one of claims from 21 to 23 having a degree of sulfation of from 2.2 to 3 and a molecular weight of from 3,500 to 5,200.

25. A LMW-K5-amine-O-oversulfate according to one of claims from 21 to 24, substantially free of N-acetyl groups.

26. A LMW-K5-amine-O-versulfate according to one of claims from 20 to 24 consisting of a mixture of chains in which at least 90% of said chains has the formula III

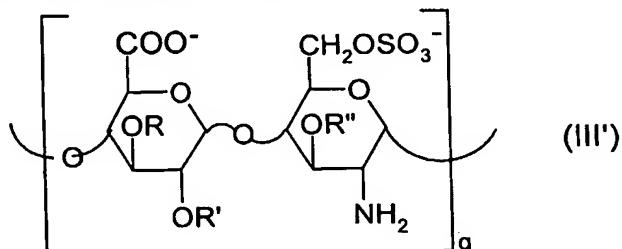


5 in which R, R' and R'' represent hydrogen or a SO3- group, n is a number between 2 and 20, containing a sulfated 2,5-anhydromannitol unit of structure (a'')



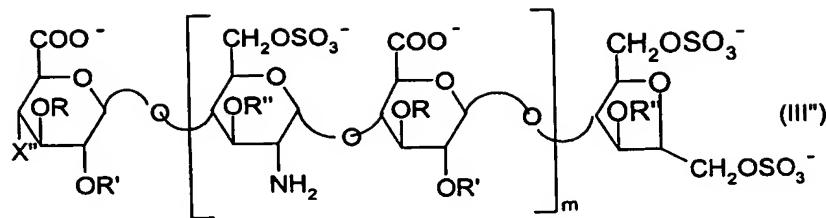
10 at the reducing end of the majority of the chains in said mixture of chains, for a degree of sulfation of from 2.2 to 3 and the corresponding cation is a chemically or pharmaceutically acceptable one.

27. The LMW-K5-amine-O-versulfate of claim 26, consisting of a mixture in which the preponderant species is a compound of formula III'



15 in which q is 4, 5, 6, 7, or 8 and the corresponding cation is a chemically or pharmaceutically acceptable one.

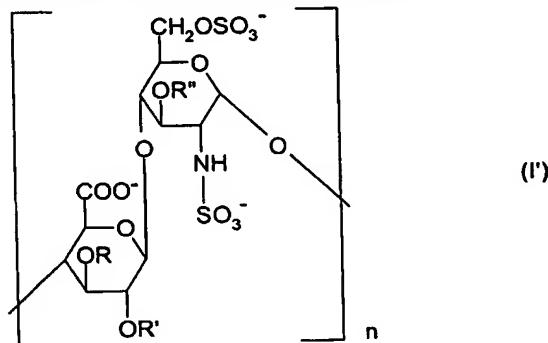
28. The LMW-O-versulfated-K5 amine of claim 27, consisting of a mixture in which the preponderant species is a compound of formula III''



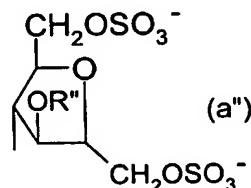
in which R, R' and R'' are hydrogen or SO_3^- , X'' is OH or OSO_3^- , for a degree of sulfation of from 2.2 to 3, m is 4, 5 or 6 and the corresponding cation is a chemically or pharmaceutically acceptable one.

5 29. A LMW-K5-N,O-oversulfate obtainable according to the process of the claims from 12 to 20.

30. A LMW-K5-N,O-oversulfate consisting of a mixture of chains in which at least 90% of said chains has the structure I'

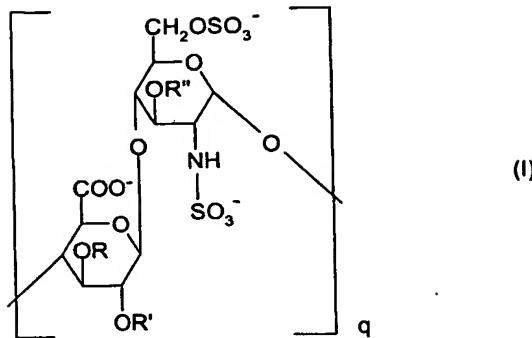


10 in which n is an integer from 2 to 20, R, R' and R'' represent hydrogen or a SO_3^- group, and in which the reducing end of the majority of said chains has the structure (a'')



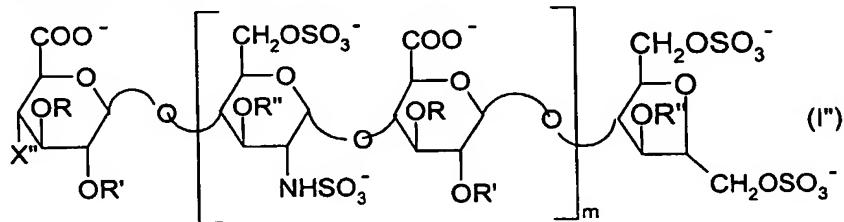
15 in which R'' is hydrogen or a SO_3^- group, for a degree of sulfation of from 3.2 to 4 and the corresponding cation is a chemically or pharmaceutically acceptable one.

31. The LMW-K5-N,O-oversulfate of the claim 30, consisting of a mixture of chains in which the preponderant species is a compound of formula I



wherein q is 4, 5, 6, 7, or 8 and the corresponding cation is a chemically or pharmaceutically acceptable one.

5 32. The LMW-K5-N,O-versulfate of claim 31, consisting of a mixture in which the preponderant species is a compound of formula I''



10 in which m is 4, 5, 6, R, R' and R'' are hydrogen or SO_3^- , for a degree of sulfation of from 3.2 to 4 and the corresponding cation is a chemically or pharmaceutically acceptable one.

33. A LMW-K5-N,O-versulfate according to one of the claims from 29 to 32 wherein said cation is the ion of an alkaline metal, an alkaline-earth metal, ammonium, tetra(C₁-C₄)alkylammonium, aluminum and zinc.

15 34. The LMW-K5-N,O-versulfate of claim 33, wherein said cation is the sodium, calcium or tetrabutylammonium ion.

35. A LMW-K5-N,O-versulfate according to one of claims from 29 to 34, having a degree of sulfation of from 3.5 to 4.

36. A LMW-K5-N,O-versulfate according to one of the claims from 29 to 34, having a degree of sulfation of from 3.5 to 3.9.

20 37. A process for the preparation of LMW-K5-N-sulfates and of their chemically or pharmaceutically acceptable salts, which comprises submitting a K5-N-sulfate to a controlled nitrous depolymerization optionally followed by a reduction and isolating the product thus obtained.

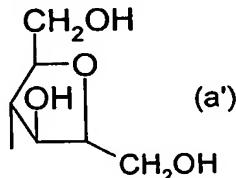
38. A process according to claim 37, wherein said K5-N-sulfates are isolated as sodium salts which is optionally converted into another chemically or pharmaceutically acceptable salt.

5 39. A process according to claim 38, wherein said other salt is that of an alkaline metal, an alkaline-earth metal, ammonium, tetra(C₁-C₄)alkylammonium, aluminum and zinc.

40. A process according to claim 39, wherein said other salt is that of sodium, calcium or tetrabutylammonium.

10 41. A LMW-K5-N-sulfate obtainable according to anyone of claims 37 to 40.

42. A LMW-K5-N-sulfate obtained according to the process of claims 37 to 40 containing a 2,5 anhydromannitol unit of structure (a')



at the reducing end of the majority of chains in said mixture of chains.

15 43. A LMW-K5-N-sulfate or a chemically or pharmaceutically acceptable salt thereof.

44. A LMW-K5-N-sulfate according to claim 43, consisting of a mixture of chains in which at least 90% of said chains has a mean molecular weight of from about 1,500 to about 7,500.

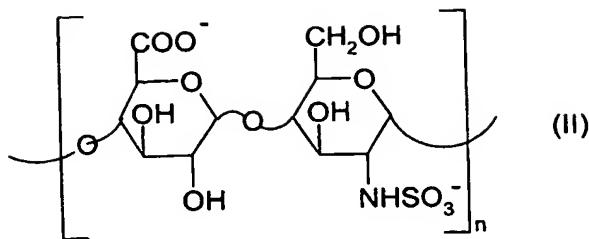
20 45. A LMW-K5-N-sulfate according to claim 44, having a molecular weight distribution from about 1,000 to about 10,000.

46. A LMW-K5-N-sulfate according to claims from 41 to 45, containing from 0 to no more than 5% acetyl groups.

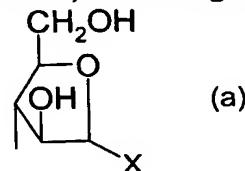
25 47. A LMW-K5-N-sulfate according to claims from 41 to 46, having a mean molecular weight of from about 2,000 to about 4,000.

48. A LMW-K5-N-sulfate according to claims from 41 to 46, having a mean molecular weight of from about 4,000 to about 7,500.

49. A LMW-K5-N-sulfate according to claims from 41 to 46, consisting of a mixture of chains in which at least 90% of said chains has the formula II

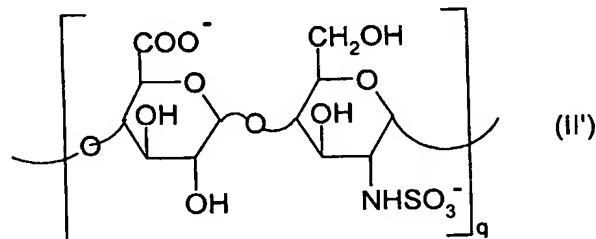


wherein n is a number from 2 to 20, containing an unit of structure



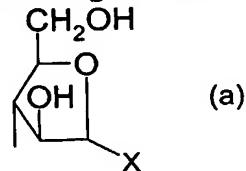
in which X represents formyl or hydroxymethyl, in the majority of said chain
5 and the corresponding cation is a chemically or pharmaceutically acceptable
one.

50. A LMW-K5-N-sulfate according to claims from 41 to 46, consisting
of a mixture of chains in which the preponderant species is a compound of
formula II'



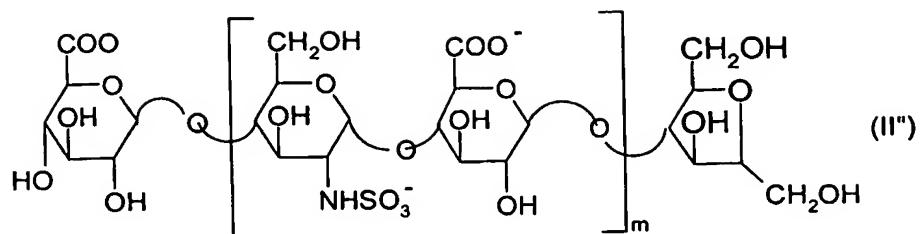
10

wherein q is 4, 5, 6, 7 or 8, containing an unit of structure



in which X represents formyl or hydroxymethyl, in the majority of said chain
15 and the corresponding cation is a chemically or pharmaceutically acceptable
one.

51. A LMW-K5-N-sulfate according to claims from 41 to 46, consisting
of a mixture of chains in which the preponderant species is a compound of
formula II"



wherein X represents formyl or hydroxymethyl, m represents 4, 5, or 6 and the corresponding cation is a chemically or pharmaceutically acceptable one.

52. A LMW-K5-N-sulfate according to claims from 49 to 51 wherein, in the structure (a), X is hydroxymethyl.

53. A LMW-K5-N-sulfate according to claims from 41 to 52, wherein said salt or cation is that of an alkaline metal, alkaline-earth metal, ammonium, tetra(C₁-C₄)alkylammonium, aluminum and zinc.

10 54. A LMW-K5-N-sulfate according to claims from 41 to 52, wherein said salt or cation is that of sodium, calcium or tetrabutylammonium.

55. A pharmaceutical composition comprising, as an active ingredient, a LMW-K5-N,O-versulfate according to one of claims from 1 to 11 or from 28 to 35, in admixture with a pharmaceutical carrier.